IV. *Contributions to Terrestrial Magnetism.* *By Major* EDWARD SABINE, *R.A. V.P.R.S.*

Received March 12,—Read March 19, 1840.

§ 1. *Lines of Inclination and Intensity in the Atlantic Ocean.* § 2. *Lines of Intensity between the Cape of Good Hope and Australia.*

§ 1. *Lines of Inclination and Intensity in the Atlantic Ocean.*

THE value of observations of the magnetic inclination and intensity *made at sea*, in determining the position and direction of the magnetic lines over those large portions of the globe which are covered by the ocean, has been justly pointed out in the scientific memoranda prepared by the Royal Society for the Antarctic Expedition; and the same publication notices the precautions which are necessary in order to eliminate, in results so obtained, the disturbing influence of the ship's iron.

The observations of Lieut. BARTHOLOMEW JAMES SULIVAN, R.N., which, by his wish and with permission of the Admiralty, will form a part of this communication, afford a practical illustration of the valuable and useful information, which a series of such observations, conducted with a proper measure of skill and patience, will produce, and of the degree of certainty which may be looked for when they are thus conducted, and when the requisite precautions are taken.

At a time when increased activity has been given to magnetic observations, in the view of obtaining correct maps of the magnetic phenomena over the whole surface of the globe corresponding to the present epoch, it has appeared desirable to place in the hands of those engaged in these researches the theoretical maps of M. GAUSS, accompanied by others in which the results of the most recent and authentic observations are inserted in their respective geographical positions; thus bringing under notice, as well as into comparison, the actual state both of theory and of experiment, and directing attention to those localities where observations have been most sparingly distributed, and where, consequently, they are most to be desired. This has been done, with regard to the maps of declination and intensity, in the publication of the Royal Society already referred to; and the theoretical map of the inclination has been republished from the German original in the Seventh Number of TAYLOR's Scientific Memoirs: but a map which should exhibit the actual observations of the latter element is yet wanting. The endeavour is made in the present communication to supply this deficiency, as far as regards that portion of the globe which is occupied by the Atlantic Ocean and its adjoining coasts. The sea observations which have contributed to this map are the series of Lieut. SULIVAN above referred to, and a series by Mr. JAMES DUNLOP of the Paramatta Observatory. The position of the lines over the surface of the land rests on above 140 determinations made on shore, within the limits of the map, between the years 1834 and 1839, of which nearly the half are now first published.

The series of Messrs. SULIVAN and DUNLOP include observations of the intensity made at sea, as well as of the inclination. I have made the necessary computations to reduce their results to the relative scale in general use. Previously, however, to any remarks which the consideration of these results may suggest, it will be proper to give some account of the observations from which they are derived.

Lieut. SULIVAN's series was made during a voyage from Falmouth to the Falkland Islands in H.M.S. Arrow in 1838; from the Falkland Islands to Rio de Janeiro in H.M.S. Stag in 1839; and from Rio back to Falmouth in the packet-ship Opossum in the same year. The instrument employed by him was a dip circle of four inches diameter, made by Mr. THOMAS JORDAN of Falmouth, furnished with two needles, one for the dip and the other for the intensity, on the plan devised by ROBERT WERE FOX, Esq., and described in the third volume of the *Annals of Electricity*, &c. The dip was in all instances observed directly, without the aid of the deflecting magnets. The values of the intensity were obtained by means of the angles of deflection from the dip, produced by the employment of constant weights applied to the axle, corrections being made for differences of temperature in the manner pointed out by Mr. Fox. The Table, Appendix A, which has been drawn up by Lieut. SULIVAN, contains the particulars of the dip observations, and of the geographical positions to which they belong; the weights used on each occasion for the intensity; the angles of deflection observed, and the same corrected for temperature; the values of the intensity resulting from the experiments with each weight, and the mean values: these are given relatively to unity in Mr. Fox's garden at Falmouth, which was the base station of Lieut. SULIVAN's observations, and, in the final column, in terms of the relative scale in common use, in which the force in London = 1·372, and at Falmouth 1·374*.

The circumstance of primary consideration in a series of intensity observations of this nature is the degree of steadiness with which the needle may have preserved its magnetic condition. The following observations, made in Mr. Fox's garden at Falmouth before and after the voyage, show that no notable alteration took place in this respect during its employment.

* Magnetic Survey of the British Islands, British Association Reports, 1838, p. 192.

Weights.	July 6th, 1838.	June 24th, 1839.	
	Angle of deflection.	Angle of deflection.	Corrected angle.
grains.	*Therm.* 67°.	*Therm.* 59°.	*Therm.* 67°.
0·8	29° 58′	29° 58′	30° 02′
0·9	34 16	34 16	34 20
1·0	38 47	38 33	38 37
1·1	43 33	43 39	43 43
1·2	48 32	48 52	48 56

And this conclusion is further corroborated by the following observations made with the same needle at Rio de Janeiro in September 1838, and April 1839.

Weights.	September 4th 1838.		April 4th, 1839.	
	Angle of deflection.	Corrected angle.	Angle of deflection.	Corrected angle.
grains.	*Therm.* 76°.	*Therm.* 67°.	*Therm.* 83°.	*Therm.* 67°.
0·8	53° 35′	53° 30′	53° 41′	53° 31′
0·9	65 12	65 07	65 25	65 15

When used on board ship the instrument was placed on a stand fitted with gimbals situated about the middle of the upper deck, and the same position was preserved in each of the three vessels. On a few occasions in the Arrow, the weather being very unfavourable, the observations were made in the cabin; these results are distinguished in the Table by a mark, signifying that they are entitled to less confidence than the others, and are omitted in the map.

A comparison was made on four occasions of the dip observed on board ship when in harbour, and with the same instrument taken on shore. These were as follows:

Falmouth, July 6th, 1838.

On shore	Dip 69° 12′·5
In the Arrow, ship's head W.N.W.	69 27

Rio de Janeiro, September 4th, 1838.

On shore	− 13 00·5
In the Arrow, ship's head S. by E.	− 13 56
In the Arrow, ship's head W.S.W.	− 13 37

Rio de Janeiro, April 4th, 1839.

On shore	− 13 00·5
In the Stag, ship's head N. by W.	− 13 10

Pernambuco, May 7th, 1839.

On shore	13 08·5
In the packet Opossum, head N.N.E.	13 10

In three of the comparisons the differences are inconsiderable, amounting only to a very few minutes; in the fourth it amounted in one observation nearly to a degree. It must be noticed, however, that it is more difficult to get true dip results on board a ship *at anchor, particularly where there is no tide*, than when under sail, because the ship's head cannot be kept so steadily on one point; and by the frequent variation in the direction of her head relatively to the magnetic meridian, the observed dip is rendered greater than the true; the error hence arising being greatest where the dip is least. Thus in all the four comparisons the dips observed on board are always somewhat in excess of those observed on shore; and it is probable, that the single difference which approached a degree in amount was occasioned by an accident of this nature. In the packet Opossum, in which more than the half of Lieut. SULIVAN's sea observations were made, the difference is less than in either of the Queen's ships, and is much within the limits of ordinary variations in successive observations made on shore. The ship's head was always placed in these comparisons as nearly as possible on the point of the compass which corresponded with the course in that part of the voyage; and, at sea, the observations were always made with the ship's head on her course, except in one instance in the Arrow, when it was varied for the sake of experiment.

The comparison of the *intensity* results on board and on shore, in similar trials, present an even more satisfactory accord; and this consists with a remark made by Lieut. SULIVAN, that by shifting the place of observation to different parts of the ship, the dip might be made to vary nearly a degree, but that in such cases the angle denoting the intensity remained nearly or wholly unaltered. The comparisons of the intensity were made only on three occasions, viz.

Rio de Janeiro, September 4th, 1838.	
On shore	Intensity 0·854
In the Arrow, head S. by E.	0·855
Rio de Janeiro, April 4th, 1839.	
On shore	0·854
In the Stag, head N. by W.	0·853
Pernambuco, May 7th, 1839.	
On shore	0·899
In the Opossum, head N.N.E.	0·900

The four observations at Rio, viz. in the Arrow, in the Stag, and at two different periods on shore, may be regarded as identical; and the two observations at Pernambuco are not less accordant.

Lieut. SULIVAN's dip results at sea are distinguished in the maps by *inclined* figures, placed on the *right* side of the mark designating the geographical position corresponding to the observation. The eastern track in the northern Atlantic and the western in the southern Atlantic are those of the outward voyage in the Arrow.

In the Archives of the Royal Society is an account by Mr. JAMES DUNLOP, Astronomer of the Observatory at Paramatta, of observations on the magnetic dip and horizontal intensity made on board the merchant ship in which he took his passage from England to Australia in 1831*. These observations were repeated daily, with very few exceptions, from the middle of June to the middle of October. The dipping-needle employed was twelve inches in length, with a circle graduated to 20′. The needle was suspended in the centre of the circle by a small frame of brass, having jewelled holes for the terminations of the axle, and turning freely in azimuth, by the directive force of the needle itself, upon two fine brass points, one above and one below, working also in jewelled holes. The whole instrument was suspended by hooking inverted Y's, attached to its upper part, on two cylinders projecting from a very fine universal joint screwed to the roof of Mr. DUNLOP's cabin. The universal joint was of rings, and could be turned on the centre, by the hand, in azimuth, to accommodate the plane of the instrument to that of the magnetic meridian indicated by the needle. The dip was observed by taking a mean of the extreme arcs of the small oscillations produced by the motion of the ship. The whole was inclosed in plate glass in the usual manner.

The intensity was observed by an apparatus similar to M. HANSTEEN's but larger, the box being about eight inches in diameter, and three inches in depth, and the tube over the centre, from which the needle was suspended by the silk fibre, was about nine inches in length. In each of the four corners of the upper side of the box was screwed a small brass pin with a hole in it, into which were hooked the ends of four copper wires which terminated in a small brass ring about $\frac{1}{8}$th of an inch in diameter over the centre of the tube, and as near the point of suspension of the needle as possible, in order that the needle and box might be suspended nearly from the same point, and also in the same line with the centre of gravity of the box. A brass wire of about $\frac{1}{20}$th of an inch in diameter was screwed about an inch into the deck, the lower end terminating in a small circular hook about the eighth of an inch in diameter, on which the box was suspended by the small ring on the vertex of the copper wires, forming a delicate universal joint.

The instruments for the dip and intensity were suspended as nearly as possible from the same part of the deck; no alteration was made in the mode of their suspension during the voyage: the trunks in the cabin contained nothing which could affect the needles, and no change was made in their disposition.

By embracing every opportunity at sea which a calm afforded of making observations with the ship's head on various points of the compass, or when alterations in the course took place in the same day, Mr. DUNLOP obtained corrections to be applied to

* I was not aware of the existence of these observations when the report "on the variations of the magnetic intensity at different parts of the earth's surface" was drawn up, or they would have been included in that memoir.

the observed values of dip and intensity, according to the direction of the ship's head during the observation. His memoir contains a statement of the data on which these were founded, and the observed as well as the corrected value of every observation. The dip results have also a correction applied for the non-coincidence of the centres of gravity and of motion of the needle, the poles not being reversed; this was obtained by Mr. DUNLOP by comparing the results on shore, in England and Paramatta, with those of needles in which the complete process was gone through. I have used in this paper the dips as thus corrected by Mr. DUNLOP himself. The intensity results are reduced to a common temperature. The needle which was employed to give the comparative values of the intensity had sustained no sensible change in its magnetic condition for above two years previously to the voyage, as shown by observations with it at Makerstown Observatory in Scotland; nor did it undergo any in the two years subsequent to the voyage, as shown by observations at the Paramatta Observatory. That it was equally steady during the intermediate time may be inferred from the relative values which it gives for the total intensity at Makerstown and Paramatta. The times of vibration were as follows:

Makerstown, March 19, 1831	. . . .	s 822·05
Paramatta, December 7, 1831	. . . .	622·90

If we take for the dip and intensity at Makerstown the values observed at the neighbouring stations of Dryburgh and Melrose*, we have the dip in March 1831, allowing for the difference of epoch, at the annual rate of a diminution of 2′·4†, 71° 50′; and the total intensity expressed by (1·372 × 1·0203 =) 1·400. At Paramatta we have the dip from the observations of Captains FITZROY, BETHUNE, and WICKHAM, R.N., as stated in the foot note‡, 62° 51′. From these data we have the total force at Paramatta by Mr. DUNLOP's needle equal to 1·665. The value determined by Capt. FITZROY, R.N., in 1836 is 1·685. We may conclude, therefore, that Mr. DUNLOP's needle suffered little or no loss of magnetism in the interval of its removal from the observatory at Makerstown to that of Paramatta.

I have availed myself of Mr. DUNLOP's results for the Atlantic Maps, from latitude 6° N. and longitude 340°, where his track parted from that of Lieut. SULIVAN's, to the meridian of the Cape of Good Hope. The observations are not strictly accordant in point of epoch with the other observations represented in the map; but the only quarter where this small difference of epoch ought to occasion discrepancy, is in the neighbourhood of the Cape of Good Hope, where, on account of the large amount of

* Magnetical Survey of the British Islands, British Association Reports, 1838.

† Vide the Report referred to, pp. 62—66.

‡ Captain FITZROY (Sydney), 1836	....	62° 49′·4	62° 51′
Captain BETHUNE (Sydney), 1837	....	62 52·7	
Captain WICKHAM (Sydney), 1838 and 1839	....	62 51·2	

There has been little or no secular change of the dip at Sydney since the commencement of the present century. (Voyage of the Adventure and Beagle, vol. i. p. 528.)

the secular change, the south dip increases in five or six years from a half to three quarters of a degree. A discrepancy to this amount in that quarter has been allowed for in tracing the isoclinal lines in the map. The Table in the Appendix (B.) contains an abstract of the corrected dip and time of horizontal vibration corresponding to the several geographical positions, taken from Mr. Dunlop's Memoir: the final column has been computed by myself, employing as a basis the observations at Makerstown and Paramatta as above stated, with the intensity at Makerstown = 1·400.

Mr. Dunlop's results are distinguished in the maps of the Atlantic by *inclined* figures placed on the *left* side of the station mark.

The results of the dip observations *made on land* are characterized by *upright* figures; the particulars concerning them are contained in the following Table and its references. In cases where two or more observers have obtained results at the same station, the mean of their results has been inserted in the map.

North and South America.

Reference.	Station.	Latitude.	Longitude.	Dip.	Observer.	Year.
		° ′	° ′	° ′		
(a)	Montreal	+ 45 27	286 30	+ 76 19	Estcourt	1838
(c)	Oswego	+ 43 26	283 30	+ 75 11	Loomis	1839
(b)	Halifax	+ 44 39	296 23	+ 75 15	Home	1834
(a)	Halifax	+ 44 39	296 23	+ 74 45	Estcourt	1838
(c)	Utica	+ 43 09	284 45	+ 74 57	Loomis	1839
(c)	Syracuse	+ 43 00	283 45	+ 74 51	Loomis	1839
(c)	Albany	+ 42 39	286 15	+ 74 40	Bache	1834
(c)	Albany	+ 42 39	286 15	+ 74 51	Loomis	1839
(c)	Buffalo	+ 42 53	281 00	+ 74 41	Loomis	1839
(c)	Schenectady	+ 42 48	286 00	+ 74 36	Loomis	1839
(a)	Drummondville	+ 43 04	280 49	+ 74 33	Estcourt	1838
(c)	Worcester	+ 42 16	288 15	+ 74 21	Loomis	1839
(c)	Cambridge	+ 42 22	289 00	+ 74 20	Loomis	1839
(c)	Springfield	+ 42 06	287 24	+ 74 11	Bache	1834
(c)	Springfield	+ 42 06	287 24	+ 74 07	Loomis	1839
(c)	Longmeadow	+ 42 02	287 30	+ 74 05	Loomis	1839
(c)	Providence	+ 41 49	288 35	+ 74 03	Bache	1834
(c)	Providence	+ 41 49	288 35	+ 74 00	Loomis	1839
(c)	Hartford	+ 41 46	287 15	+ 73 58	Loomis	1839
(c)	Westpoint	+ 41 25	285 59	+ 73 37	Courtenay	1834
(c)	Westpoint	+ 41 25	285 59	+ 73 27	Loomis	1839
(c)	New Haven	+ 41 18	287 00	+ 73 27	Loomis	1839
(c)	New York	+ 40 43	285 59	+ 72 52	Bache	1834
(c)	New York	+ 40 43	285 59	+ 72 52	Loomis	1839
(c)	Hudson	+ 41 15	279 45	+ 72 47	Loomis	1839
(c)	Princeton	+ 40 22	285 30	+ 72 47	Loomis	1839
(c)	Beaver	+ 40 44	279 30	+ 72 40	Loomis	1839
(c)	Pittsburgh	+ 40 32	280 00	+ 72 39	Loomis	1839
(c)	Philadelphia	+ 39 57	284 48	+ 72 00	Bache	1834
(c)	Philadelphia	+ 39 57	284 48	+ 72 07	Loomis	1839
(d)	Urbana	+ 40 03	276 18	+ 71 39	Locke	1838
(d)	Springfield	+ 39 53	276 13	+ 71 29	Locke	1838
(d)	Dayton	+ 39 45	275 51	+ 71 23	Locke	1838
(e)	Washington	+ 38 53	283 00	+ 71 21	Loomis	1839
(d)	Charlottesville	+ 38 02	281 29	+ 71 09	Patterson	1834
(d)	Columbus	+ 39 55	276 57	+ 71 05	Locke	1838

North and South America.

Reference.	Station.	Latitude.	Longitude.	Dip.	Observer.	Year.
(d)	Cincinnati	+ 39° 06′	275° 33′	+ 70° 46′	Locke	1838
(b)	Bermuda	+ 32 18	295 09	+ 67 31	Home	1834, 1837
(e)	Bermuda	+ 32 18	295 09	+ 65 56	Barnett	1835
(e)	Nassau	+ 25 05	282 39	+ 56 13	Barnett	1838, 1839
(e)	Contoy Island	+ 21 32	273 11	+ 49 48	Barnett	1838
(f)	St. Thomas	+ 18 20	295 06	+ 49 29	Zahrtman	1834
(b)	Antigua	+ 17 03	298 10	+ 48 46	Home	1835
(b)	Alta Vela	+ 17 28	288 21	+ 47 39	Home	1835
(b)	Jamaica	+ 17 55	283 10	+ 47 04	Home	1834
(e)	Jamaica	+ 17 55	283 10	+ 47 19	Barnett	1834
(b)	Barbadoes	+ 13 05	300 23	+ 43 37	Home	1835
(e)	Cape Gracias à Dios	+ 15 00	276 42	+ 41 04	Barnett	1833
(f)	Curaçoa	+ 12 06	291 05	+ 38 39	Zahrtman	1833
(b)	Caraccas	+ 10 30	293 10	+ 37 16	Home	1836
(g)	Realejo	+ 12 28	272 48	+ 34 37	Belcher	1838
(e)	St. John's de Nicaragua	+ 10 56	276 18	+ 34 43	Barnett	1839
(b)	St. John's de Nicaragua	+ 10 58	276 17	+ 34 05	Home	1834
(b)	Demerara	+ 6 50	302 0	+ 33 57	Home	1837
(b)	Chagres	+ 9 20	280 0	+ 32 30	Home	1834
(g)	Panama	+ 8 37	280 31	+ 31 55	Belcher	1837
(g	Magnetic Island	+ 8 05	278 14	+ 31 12	Belcher	1837
(e)	Chiriqui	+ 9 00	278 05	+ 31 11	Barnett	1839
(b)	Para	— 1 26	311 30	+ 24 08	Home	1835
(g)	Cocos Island	+ 5 53	272 58	+ 23 33	Belcher	1838
(b)	Maranham	— 2 30	315 42	+ 23 31	Home	1835
(h)	Pernambuco	— 8 04	325 09	+ 13 13	FitzRoy	1836
(i)	Pernambuco	— 8 04	325 09	+ 13 08	Sulivan	1839
(g)	Puna Island	— 2 47	280 05	+ 9 08	Belcher	1838
(h)	Bahia	— 12 59	321 30	+ 5 24	FitzRoy	1832, 1836
(k)	Bahia	— 12 59	321 30	+ 5 35	Wickham	1837
(i)	Bahia	— 12 59	321 30	+ 5 01	Sulivan	1839
(h)	Callao	— 12 04	282 52	— 7 03	FitzRoy	1835
(g)	Callao	— 12 04	282 52	— 6 14	Belcher	1838
(l)	Rio de Janeiro	— 22 55	316 51	— 12 54	Beechey	1836
(i)	Rio de Janeiro	— 22 55	316 51	— 13 00	Sulivan	1838, 1839
(i)	St. Catherine	— 27 26	311 27	— 21 40	Beechey	1836
(i)	St. Catherine	— 27 26	311 27	— 21 07	Sulivan	1838
(i)	Monte Video	— 34 53	303 47	— 34 03	Sulivan	1838
(h)	Monte Video	— 34 53	303 47	— 34 51	FitzRoy	1833
(h)	Valparaiso	— 33 02	288 19	— 38 03	FitzRoy	1835
(l)	Valparaiso	— 33 02	288 19	— 37 05	Beechey	1836
(h)	Concepçion	— 36 42	286 50	— 43 15	FitzRoy	1835
(h)	Valdivia	— 39 53	286 31	— 46 46	FitzRoy	1835
(h)	Chiloe	— 41 51	286 04	— 48 59	FitzRoy	1835
(h)	Port Low	— 43 48	285 58	— 51 20	FitzRoy	1835
(h)	Port Desire	— 47 45	294 05	— 52 43	FitzRoy	1833
(h)	Falkland Islands	— 51 32	301 53	— 53 20	FitzRoy	1834
(i)	Falkland Islands	— 51 32	301 53	— 52 40	Sulivan	1838, 1839
(h)	Port San Andres	— 46 35	284 25	— 54 14	FitzRoy	1834
(h)	R. Santa Cruz	— 50 07	291 36	— 55 16	FitzRoy	1834

Europe and Africa.

Reference.	Station.	Latitude.	Longitude.	Dip.	Observer.	Year.
(m)	London	+ 51 31	359 50	+ 69 20	Magnetic Survey	1837
(n)	Rotterdam	+ 51 55	4 26	+ 68 49	Fox	1838
(n)	Arnheim	+ 52 00	5 50	+ 68 45	Fox	1838
(o)	Brussels	+ 50 52	4 20	+ 68 31	Quetelet	1834 1839
(p)	Berlin	+ 52 30	13 24	+ 68 07	Encke	1836
(h)	Terceira	+ 38 39	332 47	+ 68 06	FitzRoy	1836
(n)	Dusseldorf	+ 51 14	6 43	+ 68 02	Fox	1838
(q)	Göttingen	+ 51 32	9 56	+ 67 50	Forbes	1837
(n)	Cologne	+ 50 57	6 46	+ 67 54	Fox	1838
(r)	Paris[a]	+ 48 52	2 21	+ 67 26	Lottin	1836
(r*)	Paris[a]	+ 48 52	2 21	+ 67 24	Arago	1835
(r)	Paris[b]	+ 48 52	2 21	+ 67 21	Duperrey	1834
(n)	Paris[c]	+ 48 52	2 21	+ 67 14	Fox	1838
(n)	Paris[d]	+ 48 52	2 21	+ 67 13	Fox	1838
(s)	Paris[a]	+ 48 52	2 21	+ 67 13	D'Abbadie	1839
(n)	Fontainbleau	+ 48 24	2 38	+ 66 59	Fox	1838
(n)	Manheim	+ 49 30	8 28	+ 66 49	Fox	1838
(n)	Baden	+ 48 45	8 17	+ 66 20	Fox	1838
(n)	Kenzigen	+ 48 10	7 47	+ 66 06	Fox	1838
(n)	Nevers	+ 47 0	3 09	+ 65 56	Fox	1838
(n)	Basle	+ 47 33	7 33	+ 65 35	Fox	1838
(n)	St. Pourcain	+ 46 19	3 17	+ 65 33	Fox	1838
(n)	Moulins	+ 46 33	3 18	+ 65 33	Fox	1838
(n)	Clermont[e]	+ 45 46	3 00	+ 65 14	Fox	1838
(n)	Clermont[f]	+ 45 47	3 05	+ 65 11	Fox	1838
(n)	Payerne	+ 46 48	6 56	+ 65 11	Fox	1838
(n)	Neweneck	+ 46 53	7 17	+ 65 10	Fox	1838
(n)	Berne	+ 46 57	7 25	+ 65 10	Fox	1838
(n)	Geneva[g]	+ 46 12	6 07	+ 64 56	Fox	1838
(n)	Geneva[h]	+ 46 12	6 07	+ 64 54	Fox	1838
(n)	Annecy	+ 45 54	6 10	+ 64 44	Fox	1838
(n)	Aix	+ 45 44	5 55	+ 64 36	Fox	1838
(n)	Grenoble	+ 45 11	5 45	+ 64 11	Fox	1838
(n)	Valence	+ 44 57	4 52	+ 64 11	Fox	1838
(t)	Milan	+ 45 28	9 09	+ 63 48	Kreil	1837
(n)	Orange	+ 44 07	4 49	+ 63 38	Fox	1838
(n)	Nismes	+ 43 50	4 20	+ 63 26	Fox	1838
(u)	Galatz	+ 45 30	28 00	+ 61 15	Ainsworth	1838
(s)	Rome	+ 41 54	12 26	+ 60 24	D'Abbadie	1839
(t)	Naples	+ 40 50	14 14	+ 58 53	Sartorius, Listing	1835
(w)	Teneriffe	+ 28 27	343 45	+ 57 28	Bethune	1836
(k)	Teneriffe	+ 28 27	343 45	+ 57 47	Wickham	1837
(i)	Teneriffe	+ 28 27	343 45	+ 57 40	Sulivan	1838
(u)	Constantinople	+ 41 00	26 39	+ 56 34	Ainsworth	1838
(h)	Port Praya	+ 14 54	336 30	+ 45 46	FitzRoy	1836
(s)	Alexandria	+ 31 13	29 54	+ 43 48	D'Abbadie	1839
(x)	Egga	+ 8 45	6 45	+ 13 51	Allen	1833
(x)	Stirling	+ 7 45	7 00	+ 11 46	Allen	1833
(x)	Fernando Po	+ 3 45	8 45	+ 0 48	Allen	1833
(x)	Ascension	− 7 56	345 36	+ 1 57	Allen	1834
(h)	Ascension	− 7 56	345 36	+ 1 39	FitzRoy	1836
(x)	Ilha das Rolhas	0 0	6 30	− 7 44	Allen	1833
(h)	St. Helena	− 15 55	354 17	− 18 01	FitzRoy	1836
(h)	Cape of Good Hope	− 34 11	18 26	− 52 35	FitzRoy	1836
(k)	Cape of Good Hope	− 34 11	18 26	− 52 54	Wickham	1837
(w)	Cape of Good Hope	− 34 11	18 26	− 52 26	Bethune	1837

[a] Observatoire. [b] Depôt des Cartes. [c] Garden of the Ecole des Mines. [d] Jardin des Plantes.
[e] East side of Puy de Dôme. [f] One mile west of the city.
[g] Outside the city wall. [h] Near the observatory.

References.

(a) Magnetical observations by Lieut.-Colonel JAMES BUCKNALL ESTCOURT, 43rd Light Infantry: MSS. in the possession of ROBERT WERE FOX, Esq.

(b) Magnetical observations by Captain Sir EVERARD HOME, Bart., R.N., reduced by the Rev. GEORGE FISHER, F.R.S.; Philosophical Transactions, 1838, Part II. Art. XVI.

(c) Magnetical observations in the United States. Communicated in the Proceedings of the American Philosophical Society, vol. i. No. 9.

(d) Observations of the Magnetic Dip by Messrs. LOCKE and PATTERSON, communicated by Professor ELIAS LOOMIS in SILLIMAN'S Journal, July 1838, Art. 3.

(e) Magnetical observations by Commander EDWARD BARNETT, R.N.; MSS. in the Hydrographic Office; Appendix C.

(f) Magnetical observations by Captain ZAHRTMANN, of the Royal Danish Navy, reported in DOVE'S Repertorium, B[d] II. page 191.

(g) Magnetical observations by Captain EDWARD BELCHER, R.N.; MSS. in the Hydrographic Office; Appendix D.

(h) Magnetical observations made during the voyages of H.M. ships Adventure and Beagle, discussed by Major SABINE, R.A., in the Appendix to KING and FITZROY'S account. The observations employed on the present occasion are those made by the officers of the Beagle from the winter of 1833–1834 to the end of the voyage.

(i) Lieut. SULIVAN'S observations, Appendix A.

(k) Magnetical observations by Commander JOHN WICKHAM, R.N.; MSS. in the Hydrographic Office; Appendix E.

(l) Magnetical observations by Captain FREDERICK BEECHEY, R.N.; MSS. in the Hydrographic Office; Appendix F.

(m) Magnetic Survey of the British Islands, 1837; Reports of the British Association, 1838.

(n) Magnetical observations by ROBERT WERE FOX, Esq., in manuscript; Appendix L.

(o) Mém. de l'Acad. Royale des Sciences de Bruxelles, tome xii.

(p) Astron. Jahrbuch, 1839.

(q) GAUSS and WEBER, Resultate, &c., 1838, p. 98.

(r) Bulletin de l'Acad. Royale des Sciences de Bruxelles, tome 6[me], 1[ere] partie, p. 473.

(r*) Annuaire, 1836.

(s) Communicated in manuscript in a letter from M. D'ABBADIE to Captain BEAUFORT, R.N.

(t) GAUSS, Allgemeine Theorie, &c., page 42.

(u) Magnetical observations by WILLIAM AINSWORTH, Esq.; Journal of the Royal Geographical Society, vol. viii. Art. XXVI.

(w) Magnetical observations by Captain CHARLES DRINKWATER BETHUNE, R.N.; MSS. in the Hydrographic Office; Appendix G.

(x) Magnetical observations by Commander WILLIAM ALLEN, R.N.; MSS. in the Hydrographic Office; Appendix H.

In comparing the line of no dip, deduced from the observations now collected, with the same line in the map corresponding to the year 1825, taken principally from the observations of Captain Duperrey*, the differences which appear are everywhere conformable to what is known regarding the secular changes of that element, and are within the limits of the probable effects of those changes. On the American side, the line in 1837 is *slightly* to the southward of its position in 1825. On the African side, the alteration is in the opposite direction, and is greater, corresponding to the rapidity with which the node, or point of intersection of the line of no dip and of the geographical equator, is in progress of translation to the westward. We may infer, with some degree of approximation at least, the rate at which this transference is taking place, from the observations of Captain Allen in December 1833 at the Ilha das Rolhas, at the southern extremity of the island of St. Thomas, compared with those which I obtained in May 1822 at Fernandilla, and at the Ilha das Cabras, both near the northern extremity of the same island. Captain Allen's station was distant from mine about twenty-six miles in a north and south direction, which in that part of the globe is equivalent to a difference of about twice as many minutes of dip. By my observations there was no dip at the northern extremity of St. Thomas in May 1822; and by Captain Allen's observations made at its southern extremity in 1833, allowing for the twenty-five miles distance apart of the two places of observation, the south dip at the northern extremity in December 1833 appears to have been about 7° S., showing a secular change of 7° in $11\frac{1}{2}$ years, or on the average 39′ in each year. Taking into account the angle which the lines of dip in that quarter make with the meridian, the intersection of the line of no dip and the geographical equator should be transferred to the westward, by a secular change of that amount, at an annual rate of half a degree. It would also follow, that in 1833 the line of no dip should be found, in or near the meridian of St. Thomas, about $3\frac{1}{2}$° to the north of the position it occupied in 1822; and that this was very nearly the fact we may infer from Captain Allen's observations at Fernando Po in 3° 45′ N. latitude, which gave in December 1833 a dip of 0° 48′ N.

Messrs. Dunlop and Sulivan's intensity results in the Atlantic Ocean are shown in Plate V., where also the isodynamic lines are drawn with the best approximation afforded by the observations hitherto obtained, including the present. Mr. Dunlop's results are distinguished by inclined figures placed on the left of the station marks, and Lieut. Sulivan's sea results by inclined figures placed on the right of the station marks: his land results are shown by upright figures.

In passing from the northern to the southern hemisphere, Lieut. Sulivan found the intensity continually diminish until about the parallel of —23°, in long. 317°, from whence, in his further progress southward, it again increased. In returning from the

* Philosophical Magazine, February 1839. Represented by a dotted line in the isoclinal map in this communication.

southern to the northern hemisphere, his observation of the weakest intensity was made in — 22½° in the meridian of 325°. In Mr. DUNLOP's passage from the North to the South Atlantic he observed the weakest intensity in — 27°, in the more easterly meridian of 339°. The three geographical positions in which these gentlemen must have crossed the *line of least intensity* will be found, on examination, in very near accordance with my delineation of that line in the Philosophical Magazine for February 1839, which is repeated in the present map.

Lieut. SULIVAN crossed the line of *no dip*, as indicated by his observations, between the latitudes — 13° 50′ and — 16° 0′, about the meridian of 324°, in his outward passage; and between the latitudes — 15° 10′ and — 15° 44′, near the same meridian, in his homeward passage. Mr. DUNLOP's observations place that line in about — 13° latitude, in the meridian of 335° or thereabouts. These observations are also closely accordant with the representation of the line of no dip laid down in the map referred to in the Philosophical Magazine, and repeated in Plate III. They add confirmation, if any were needed, to the non-identity of the lines of no dip and of least intensity, and to their wide separation in the part of the globe under consideration. This is a marked feature in the system of the magnetic lines at the present epoch, known for some years to those who have carefully attended to the progress of experiment, but not generally recognised till very recently.

In addition to the observations of Messrs. DUNLOP and SULIVAN I have inserted in Plate V., in upright figures, the results of a series of intensity results obtained by ROBERT WERE FOX, Esq., on the continent of Europe in 1838, by his own method of experimenting. The details of this series are given in the Appendix L.

§ 2. *Between the Cape of Good Hope and New South Wales.*

Mr. DUNLOP's observations (Appendix B.) furnish us with a series of dip and intensity results obtained at sea between the meridian of the Cape of Good Hope and New South Wales, and between the parallels of —35° and —41°; a part of the globe from whence no *recent* data at least have been obtained for the lines of dip, and where materials for the lines of intensity were previously wholly wanting. The form which the isodynamic lines assume in that quarter will admit of the connection being approximately traced, between Mr. DUNLOP's intensity results and the positions of the lines in New South Wales as determined at several points of the coast by observations already published, or which will be now communicated. This connection is shown in Plate VI., in which the intensity results are inserted in upright figures. The materials are too few, and too widely scattered, for the lines thus traced to be regarded as more than a first approximation; but as such they may be useful. The form of the isoclinal lines in this part of the globe being less simple than that of the isodynamics, the materials are yet insufficient to admit of their being represented in any satisfactory manner; but the results themselves are inserted in the Plate in inclined figures in their respective localities.

The observations on the coast of New South Wales are contained in the following table, and the particulars of those which are now first published are given in the Appendix under the respective references.

Reference.	Station.	Latitude.	Longitude.	Dip.	Intensity.	Observer.	Year.
(a)	Hobart Town	−42 53	147 24	−70 35	1·817	FitzRoy	1836
(b)	Hobart Town	−42 53	147 24	−70 25	1·830	Wickham........	1838
(c)	Hobart Town	−42 53	147 24	−70 31	1·810	Franklin	1837, 1838
(a)	Sydney	−33 51	151 17	−62 49	1·685	FitzRoy	1836
(b)	Sydney, including Paramatta and Dunheved	−33 51	151 17	−62 51	1·682	Wickham........	1838, 1839
(d)	Sydney, including Paramatta and Dunheved	−33 51	151 17	−62 53		Bethune	1831
(e)	Paramatta	−33 51	151 17	−62 51	1·665	Dunlop	1831
(b)	Port George IV.........	−15 20	124 40	−41 29	1·334	Wickham........	1838
(b)	Point Swan............	−16 21	123 03	−43 07	1·324	Wickham........	1838
(b)	Port Usborne	−16 39	123 34	−43 26	1·340	Wickham........	1838
(b)	Swan River............	−32 03	115 41	−62 24	1·654	Wickham........	1837, 1838
(a)	King George's Sound....	−35 02	117 56	−64 41	1·709	FitzRoy	1836
(b)	Bass's Strait	−40 28	151 35	−69 08	1·793	Wickham........	1838

References.

(a) Voyage of the Adventure and Beagle, vol. i. p. 522.

(b) Observations by Commander JOHN WICKHAM, R.N.; MSS. in the Hydrographic Office; Appendix E. and I.

(c) Observations made at Hobart Town at the request of the Lieut.-Governor Sir JOHN FRANKLIN, transmitted to Major SABINE; Appendix K.

(d) Observations by Captain CHARLES DRINKWATER BETHUNE, R.N.; MSS. in the Hydrographic Office of the Admiralty; Appendix G.

(e) Observations comprised in the present communication, page 136.

APPENDIX A.

Lieut. SULIVAN's observations of the Dip and Intensity made at sea between Falmouth and the Falkland Islands.

[N.B. The observations marked * were made in unfavourable weather, and in the cabin of the ship, and are not entitled to equal confidence with the others.]

Place.	Latitude.	Long. E.	Ship's head.	Dip.	Intensity.					
					Therm.	Weight.	Angle of deflection.	Corrected angle.	Falmouth. = 1·000.	London. = 1·372.
	° ′	° ′		° ′	°	grs.	° ′	° ′		
Falmouth, Mr. Fox's Garden, July 6, 1838	50 09	354 54		69 12·5	67	0·8	29 58	29 58	1·000	1·374
						0·9	34 16	34 16	1·000	
						1·0	38 47	38 47	1·000	
						1·1	43 33	43 33	1·000	
						1·2	48 32	48 32	1·000	
H.M.S. Arrow ..	50 09	354 54	W.N.W.	69 27	......	......	......	......	......	
At sea*	49 0	353 10	W.S.W.	67 18	67	1·0	40 26	40 26	0·966	1·331
						1·1	45 11	45 11	0·971	
At sea*	46 9	350 30	W.	67 49	71	1·0	40 7	40 5	0·973	1·328
						1·1	45 56	45 54	0·959	
At sea*	43 16	349 38	S.W.	65 58	75	1·0	40 48	40 43	0·961	1·323
						1·1	45 37	45 32	0·965	
At sea*	40 15	346 44	S.W.	64 32	76	1·0	40 41	40 36	0·962	1·320
						1·1	45 56	45 51	0·960	
At sea..........	37 28	346 4	S.W.	63 2	77	1·0	42 48	42 42	0·924	1·277
						1·1	47 56	47 50	0·929	
						1·2	53 19	53 13	0·935	
At sea..........	34 35	344 48	S.W.	61 7	75	1·0	43 26	43 21	0·913	1·265
						1·1	48 37	48 32	0·920	
						1·2	53 56	53 51	0·928	
Santa Cruz, Commandant's Garden......	28 27	343 45		57 40	85	1·0	43 10	43 0	0·914	1·254
						1·1	49 7	48 57	0·913	
						1·2	55 25	55 15	0·912	
At sea..........	24 57	340 57	S.	54 15	81	1·1	51 19	51 11	0·884	1·214
			W.	55 45		1·1	51 26	51 18	0·883	
At sea..........	23 10	339 15	W.	53 26	77	1·1	52 3	51 57	0·875	1·203
At sea..........	18 20	335 30	S.W.	50 45	79	1·1	53 22	53 15	0·859	1·181
At sea..........	14 3	333 30	S. by W.	45 26	81	1·1	55 3	54 55	0·841	1·155
At sea..........	12 5	333 40	S.	42 45	80	1·1	57 7	56 59	0·822	1·129
At sea..........	8 48	334 32	S. by W.	37 7	81	1·1	60 0	59 53	0·796	1·094
At sea..........	6 32	336 23	S.E.	33 45	81	1·1	67 45	67 37	0·745	1·024
At sea..........	4 12	335 30	S.W. by S.	30 35	80	1·1	73 15	73 7	0·720	0·989
At sea..........	1 12	331 16	S.W. by S.	26 27	80	1·1	71 30	71 22	0·727	0·999
At sea..........	− 2 35	328 50	W.S.W.	21 55	82	1·1	78 0	77 51	0·705	0·969
At sea..........	− 6 20	327 20	S. by W.	15 57	82	0·8	45 45	45 36	0·699	0·956
						1·0	65 22	65 13	0·690	
At sea..........	−10 8	325 42	S. by W.	10 50	80	0·8	48 30	48 23	0·668	0·911
At sea..........	−13 50	324 41	S. by W.	1 50	78	0·8	50 45	50 40	0·646	0·881
At sea..........	−16 0	323 42	S.	− 1 25	78	0·8	50 37	50 32	0·647	0·882
At sea*	−18 35	323 0	S. by W.	− 7 40	79	0·8	50 30	50 24	0·648	0·883
Rio de Janeiro Villegagnon Is.	−22 55	316 51		−13 0·5	76	0·8	53 35	53 30	0·621	0·854
						0·9	65 12	65 7	0·621	
Rio de Janeiro H.M.S. Arrow	−22 55	316 51	S. by E.	−13 56	77	0·8	53 30	53 24	0·622	0·855
			W.S.W.	−13 37						
At sea..........	−24 35	315 55	S.W.	−17 55	76	0·8	52 7	52 2	0·633	0·869
At sea..........	−26 35	312 55	S.W.	−21 17	76	0·8	53 7	53 2	0·625	0·859
Santa Catherin Anhatomirim ..	−27 26	311 25		−21 7	77	0·8	50 5	49 59	0·652	0·892
						0·9	60 32	60 26	0·647	

TABLE. (Continued.)

Place.	Latitude.	Long. E.	Ship's head.	Dip.	Intensity.					
					Therm.	Weight.	Angle of deflection.	Corrected Angle.	Falmouth. =1·000.	London. =1·372.
	° ′	° ′		° ′	°	grs.	° ′	° ′		
At sea*	−31 44	310 40	W.S.W.	−28 22	74	0·8	45 45	45 40	0·698	0·951
						1·0	66 0	65 55	0·686	
Monte Video .. Rat Island	−34 53	303 47		−34 03	72	0·8	43 24	43 22	0·727	1·004
						1·0	58 37	58 35	0·734	
At sea	−38 50	303 20	S.	−40 15	60	1·0	52 45	52 49	0·786	1·080
At sea	−40 40	304 40	S.S.W.	−43 15	61	1·0	50 52	50 55	0·807	1·109
At sea	−42 6	302 50	S.	−45 45	62	1·0	48 7	48 10	0·841	1·155
At sea*	−46 0	299 50	S.S.W.	−50 15	61	1·0	40 52	40 55	0·956	1·313
Berkley Sound, Falkland Islands, Oct. 18, 1838.	....	....		−52 40	51	1·0	41 3	41 14	0·950	1·295
						1·1	46 22	46 33	0·949	
						1·2	52 51	52 2	0·938	
Dec. 17, 1838.	−51 32	301 53		−52 38	56	0·8	32 27	32 34	0·928	
						0·9	36 41	36 48	0·940	
						1·0	41 26	41 33	0·944	
						1·1	46 41	46 48	0·947	
Feb. 16, 1839.	....	....		−52 43	63	0·9	36 56	36 58	0·936	
						1·0	41 19	41 21	0·948	
						1·1	46 55	46 57	0·943	
						1·2	52 59	53 1	0·938	
H.M.S. Stag .. At sea	−49 40	305 13	N. by E.	−49 45	66	1·0	44 0	44 1	0·902	1·236
						1·1	50 7	50 8	0·898	
At sea	−46 53	309 6	N.N.E.	−45 54	59	1·0	48 37	48 42	0·834	1·150
						1·1	55 0	55 5	0·840	
At sea	−44 4	312 1	N.N.E.	−43 15	63	1·0	50 45	50 47	0·809	1·117
						1·1	57 15	57 17	0·818	
At sea	−42 2	314 49	N.N.E.	−40 45	63	1·0	56 7	56 9	0·754	1·039
						1·1	65 22	65 24	0·758	
At sea	−40 50	315 40	N. by E.	−37 45	63	1·0	59 0	59 2	0·730	1·005
						1·1	70 7	70 9	0·732	
At sea	−38 48	316 8	N. by E.	−36 15	62	0·9	52 0	52 3	0·714	0·981
						1·0	61 15	61 18	0·714	
At sea	−36 10	317 5	N. by E.	−34 30	67	0·9	55 22	55 22	0·684	0·944
						1·0	65 15	65 15	0·690	
At sea	−29 47	315 50	N.N.W.	−24 0	72	0·8	51 37	51 35	0·638	0·880
						0·9	61 22	61 20	0·641	
At sea	−24 40	317 35	N.	−16 57	74	0·8	54 52	54 48	0·612	0·847
						0·9	65 15	65 11	0·620	
Rio de Jan., Villegagnon Well, April 4, 1839.	−22 55	316 51		−13 05	83	0·8	53 41	53 31	0·621	0·854
						0·9	65 25	65 15	0·620	
Rio de Janeiro, H.M.S. Stag ..	−22 55	316 51	N. by W.	−13 10	76	0·8	53 38	53 33	0·621	0·853
						0·9	65 30	65 25	0·619	
Opossum Packet At sea	−23 09	317 5	S.E.	−13 55	83	0·8	54 17	54 7	0·617	0·850
						0·9	65 37	65 27	0·619	
At sea	−23 27	321 50	N.E. by E.	−12 52	82	0·8	57 0	56 51	0·598	0·824
						0·9	69 30	69 21	0·602	
At sea	−23 5	323 39	N.E. by E.	−13 0	81	0·8	57 59	57 51	0·590	0·813
						0·9	71 22	71 14	0·594	
At sea	−22 21	325 34	N.E. by E.	−12 37	80	0·8	59 45	59 38	0·579	0.800
						0·9	74 11	74 4	0·585	
At sea	−21 40	325 55	N.	−10 55	81	0·8	55 56	55 48	0·604	0·829
						0·9	69 11	69 3	0·603	
At sea	−19 56	325 5	N. by W.	− 7 7	82	0·8	54 56	54 47	0·612	0·841
						0·9	67 4	66 55	0·612	
At sea	−17 52	324 36	N.	− 3 37	82	0·8	53 52	53 43	0·620	0·854
						0·9	65 3	64 54	0·622	

TABLE. (Continued.)

Place.	Latitude.	Long. E.	Ship's head.	Dip.	Intensity.					
					Therm.	Weight.	Angle of deflection.	Corrected angle.	Falmouth. =1·000.	London. =1·372.
	° ′	° ′		° ′	°	grs.	° ′	° ′		
At sea	−15 44	323 58	N.	− 0 22	81	0·8	52 37	52 29	0·630	0·864
						0·9	63 41	63 33	0·629	
At sea	−15 10	323 26	N.N.W.	1 37	82	0·8	52 37	52 28	0·630	0·867
						0·9	63 7	62 58	0·632	
At sea	−13 36	322 20	N.N.W.	4 22	82	0·8	51 18	51 8	0·642	0·883
						0·9	61 3	60 53	0·644	
Bahia Arsenal	−12 59	321 30		5 1	84	0·8	53 18	53 8	0·624	0·859
						0·9	64 24	64 14	0·625	
Pernambuco Arsenal	− 8 04	325 9		13 8½	85	0·8	50 45	50 34	0·651	0·900
						0·9	59 9	58 58	0·657	
						1·0	73 22	73 11	0·654	
Pernambuco, Packet Opossum	− 8 04	325 9	N.N.E.	13 10	84	0·8	49 46	49 36	0·656	0·900
						0·9	59 31	59 21	0·654	
At sea	− 6 23	325 20	N. by E.	15 57	84	0·8	47 0	46 50	0·682	0·939
						0·9	55 45	55 35	0·685	
At sea	− 2 54	325 03	N. by E.	22 32	84	0·8	45 7	44 57	0·707	0·974
						0·9	52 37	52 27	0·710	
At sea	− 0 27	324 44	N. by E.	27 32	83	0·8	42 37	42 27	0·740	1·018
At sea	1 10	324 39	N. by W.	30 32	83	0·9	47 21	47 11	0·762	1·051
						1·0	55 24	55 14	0·767	
At sea	2 7	324 19	N.W.	32 2	85	0·9	47 21	47 10	0·768	1·051
						1·0	55 20	55 9	0·763	
At sea	5 10	322 53	N.W. by N.	36 22	80	0·9	43 54	43 47	0·814	1·116
						1·0	50 40	50 33	0·811	
At sea	7 22	320 53	N.N.W.	39 32	80	0·9	41 14	41 7	0·856	1·172
						1·0	47 31	47 24	0·851	
At sea	10 7	319 51	N. by W.	42 27	79	0·9	39 37	39 30	0·885	1·214
						1·0	45 22	45 15	0·882	
At sea	12 50	318 28	N.N.W.	47 5	79	0·9	38 25	38 18	0·908	1·248
						1·0	43 41	43 34	0·908	
At sea	15 40	317 36	N. ½ W.	50 7	79	0·9	36 46	36 39	0·943	1·299
						1·0	41 30	41 23	0·947	
At sea	18 28	317 7	N. ½ E.	52 57	79	1·0	41 1	40 54	0·957	1·314
						1·1	46 18	46 11	0·955	
At sea	21 32	316 43	N.N.E.	56 50	79	1·0	39 16	39 9	0·992	1·366
						1·1	43 50	43 43	0·996	
At sea	23 49	316 40	N.N.E.	58 47	79	1·0	37 56	37 49	1·021	1·403
						1·1	42 27	42 20	1·023	
At sea	24 43	316 55	N.E. by N.	59 47	80	1·0	37 53	37 45	1·023	1·410
						1·1	42 9	42 1	1·029	
At sea	25 48	317 19	N.E. by N.	60 50	79	1·0	37 12	37 5	1·039	1·429
						1·1	41 35	41 28	1·041	
At sea	27 10	317 49	N.E. by N.	62 2	79	1·0	37 0	36 53	1·044	1·436
						1·1	41 15	41 8	1·047	
At sea	27 51	318 27	N.E. by N.	62 27	79	1·0	36 35	36 28	1·054	1·449
						1·1	40 55	40 48	1·055	
At sea	28 36	317 30	N.W. by W.	62 52	78	1·0	36 26	36 19	1·058	1·454
						1·1	40 45	40 38	1·058	
At sea	30 0	318 5	N.E.	64 5	79	1·0	36 9	36 2	1·065	1·464
						1·1	40 25	40 18	1·065	
At sea	31 57	319 0	N.E.	64 55	78	1·0	36 11	36 4	1·064	1·470
						1·1	39 55	39 48	1·076	
At sea	34 27	320 54	E.N.E.	67 50	69	1·0	35 17	35 16	1·085	1·490
						1·1	39 23	39 22	1·086	
At sea	35 9	321 58	N.N.E.	67 35	68	1·0	34 58	34 57	1·093	1·499
						1·1	39 13	39 12	1·090	

TABLE. (Continued.)

Place.	Latitude.	Long. E.	Ship's head.	Dip.	Intensity. Therm.	Weight.	Angle of deflection.	Corrected angle.	Falmouth. = 1·000.	London. = 1·372.
	° ′	° ′		° ′	°	grs.	° ′	° ′		
At sea..........	36 53	322 30	N.E. by E.	68 15	66	1·0	35 0	35 1	1·092	1·498
						1·1	39 19	39 20	1·087	
At sea..........	38 21	323 40	E.N.E.	69 42	67	1·0	35 15	35 15	1·085	1·490
						1·1	39 22	39 22	1·086	
At sea..........	39 44	325 54	E.	69 25	67	1·0	35 55	35 55	1·068	1·473
						1·1	39 52	39 52	1·075	
At sea..........	40 49	328 22	E.	70 2	67	1·0	36 7	36 7	1·063	1·467
						1·1	40 2	40 2	1·071	
At sea..........	41 56	330 40	E.	69 52	67	1·0	36 46	36 46	1·047	1·443
						1·1	40 55	40 55	1·052	
At sea..........	42 42	333 8	E.	69 50	67	1·0	36 57	36 57	1·042	1·431
						1·1	41 30	41 30	1·040	
At sea..........	43 32	336 5	E. by S.	69 47	64	1·0	37 10	37 12	1·036	1·425
						1·1	41 33	41 35	1·038	
At sea..........	45 27	342 53	E. ½ N.	69 30	61	1·0	37 32	37 36	1·027	1·410
						1·1	42 10	42 14	1·025	
At sea..........	47 7	346 52	E. ½ N.	68 52	62	1·0	38 15	38 18	1·011	1·392
						1·1	42 40	42 43	1·015	
Falmouth, Mr. Fox's Garden, June 24, 1839.	50 09	354 54		69 18	59	0·8	29 58	30 02	0·998	1·374
						0·9	34 16	34 20	0·998	
						1·0	38 33	38 37	1·004	
						1·1	43 39	43 43	0·997	
						1·2	48 52	48 56	0·994	

B.

Mr. Dunlop's Observations of the Dip and Intensity, made at sea in a voyage from England to Australia.

Date.	Latitude.	Longitude. E.	Dip.	Time of horizontal vibration.	Intensity. London = 1·372.	Date.	Latitude.	Longitude. E.	Dip.	Time of horizontal vibration.	Intensity. London = 1·372.
1831.	° ′	° ′	° ′	s		1831.	° ′	° ′	° ′	s	
July 23.	5 37	341 3	28 27	576·0	1·01	Aug. 26.	−35 31	344 15	−35 44	642·4	0·88
24.	5 23	342 35	26 13	576·6	1·00	27.	−36 36	347 24	−38 02	653·8	0·88
25.	4 57	344 16	24 34	570·6	1·00	28.	−37 12	350 24	−39 16	652·0	0·90
26.	4 48	346 3	23 21	568·8	1·00	29.	−37 37	353 36	−40 50	654·4	0·91
27.	4 14	345 31	22 38	570·7	0·98	30.	−37 40	355 51	−41 51	658·1	0·92
28.	3 52	347 2	20 51	Not obs.		31.	−38 44	0 16	−43 44	676·2	0·91
28.	3 36	347 53	20 5	569·5	0·97	Sept. 1.	−39 03	3 16	−44 48	678·2	0·91
29.	3 18	349 16	19 37	568·9	0·97	2.	−39 45	4 40	−46 24	680·0	0·92
30.	2 37	347 40	19 44	565·0	0·99	3.	−39 10	6 20	−46 55	686·1	0·93
30.	2 27	347 20	19 14	Not obs.		4.	−39 00	10 12	−48 31	692·0	0·93
31.	1 53	346 20	18 35	569·6	0·96	5.	−39 07	14 0	−49 55	689·4	0·96
Aug. 1.	− 0 53	344 36	17 22	569·6	0·95	6.	−39 22	17 24	−50 59	691·5	0·98
2.	− 1 52	342 31	14 40	571·0	0·94	7.	−39 06	20 00	−52 03	703·1	0·97
3.	− 4 3	341 37	11 28	568·1	0·93	8.	−39 00	23 00	−54 01	704·4	1·01
4.	− 6 2	341 02	8 24	573·2	0·91	9.	−38 04	25 00	−55 10	697·7	1·06
5.	− 8 10	339 50	5 12	577·7	0·89	11.	−39 16	30 27	−58 11	712·4	1·10
6.	− 9 45	337 53	3 09	574·9	0·89	12.	−39 26	33 30	−59 05	716·0	1·12
7.	−10 12	337 42	1 38	581·5	0·87	13.	−39 16	35 37	−60 01	731·4	1·10
8.	−12 51	336 10	0 35	577·7	0·88	14.	−37 30	37 27	−58 11	720·1	1·08
9.	−14 31	334 30	− 1 05	583·4	0·87	15.	−35 20	39 07	−58 33	712·7	1·11
10.	−16 12	333 10	− 4 02	581·0	0·88	16.	−35 10	40 50	−59 54	718·6	1·14
11.	−18 09	332 48	− 7 10	593·7	0·84	17.	−35 54	43 16	−61 08	717·6	1·19
12.	−19 47	332 45	−10 13	591·1	0·86	19.	−35 01	48 06	−60 27	711·1	1·18
13.	−21 08	333 04	−12 12	594·7	0·85	21.	−36 18	52 48	−62 46	712·4	1·27
14.	−23 06	334 39	−15 12	603·0	0·84	22.	−37 07	55 20	−63 13	719·7	1·27
15.	−25 02	336 50	−17 45	611·9	0·83	23.	−37 40	59 15	−63 54	721·8	1·29
16.	−26 12	339 12	−19 50	608·2	0·85	24.	−37 46	63 38	−63 51	723·0	1·28
17.	−25 56	340 34	−22 01	623·0	0·82	25.	−37 50	66 04	−64 10	719·2	1·31
18.	−27 02	339 15	−23 46	629·0	0·81	26.	−38 15	69 31	−65 04	713·1	1·38
19.	−27 51	337 51	−24 57	628·5	0·82	27.	−39 31	74 00	−65 02	713·8	1·37
20.	−29 06	337 17	−26 20	619·8	0·86	29.	−39 27	81 00	−66 07	Not obs.	
21.	−29 30	336 40	−26 02	619·1	0·86	Oct. 2.	−40 12	91 14	−67 26	703·6	1·55
22.	−30 18	337 05	−27 11	621·0	0·86	4.	−41 02	99 29	−68 02	699·6	1·61
23.	−30 47	337 26	−28 05	621·4	0·87	5.	−41 18	103 53	−68 15	698·3	1·63
24.	−32 01	338 08	−30 13	623·0	0·88	10.	−42 32	122 36	−70 19	711·4	1·73
25.	−33 39	341 00	−32 46	628·2	0·89						

C.

The observations of Commander Edward Barnett, R.N., were made with a dipping instrument, the construction of which was favourably spoken of by S. H. Christie, Esq., in a paper read before the Royal Society in April 1833, as noticed in Commander Barnett's report. The needle having been used for the intensity as well as for the dip, the dip results are derived from observations in four positions only of the instrument, the poles of the needle not being changed in the course of each observation.

D.

The observations of Captain Edward Belcher, R.N., are part of a very extensive series, principally on the coast and islands of the Pacific Ocean, which is still in progress, and of which the details will be more conveniently given on a future occasion, when the series is completed.

E.

Observations on the dip made by Commander John Wickham, R.N., with a circle by Robinson of six inches in diameter furnished with two needles.

Date.	Needle.	Poles. α direct. β reversed.	Dip.	Station.
1837.		° ′	° ′	
June 26.	1	α 69 18 β 69 10	69 14	Plymouth, Athenæum.
	2	α 69 04 β 69 15	69 09	
July 20.	1	α 57 45 β 57 47	57 46	Santa Cruz, Teneriffe.
	2	α 57 55 β 57 35	57 45	
July 22.	1	α 57 50 β 57 48	57 49	Santa Cruz, Teneriffe.
	2	α 57 39 β 57 58	57 49	
Aug. 21.	1	α 5 42 β 5 22	5 32	Bahia.
	2	α 6 06 β 5 09	5 37	
Sept. 26.	1	α −53 03 β −52 48	−52 56	Cape of Good Hope, Dock Yard.
	2	α −53 11 β −52 31	−52 51	
Oct. 7.	1	α −52 50 β −53 04	−52 57	Cape of Good Hope, The Admiral'sGarden.
	2	α −52 35 β −53 09	−52 52	
Nov. 22.	1	α −62 27 β −62 19	−62 23	Swan River, Pier.
	2	α −62 34 β −62 14	−62 24	
1838.				
Feb. 5.	1	α −42 58 β −43 15	−43 07	Point Swan.
	2	α −42 47 β −43 27	−43 07	
Mar. 24.	1	α −43 29 β −43 23	−43 26	Port Usborne.
	2	α −43 48 β −43 04	−43 26	
1838.		° ′	° ′	
April 15.	1	α −41 28 β −41 31	−41 30	Port George IV.
	2	α −41 08 β −41 50	−41 29	
June 15.	1	α −62 28 β −62 21	−62 24	Swan River Pier.
	2	α −62 38 β −62 14	−62 26	
July 12.	1*	α −69 57 β −71 01	−70 29	Hobart Town.
	2*	α −70 58 β −69 41	−70 19	
13.	1	α −70 20 β −70 27	−70 24	Government House.
	2	α −70 19 β −70 32	−70 26	
Oct. 25.	1	α −62 56 β −62 49	−62 53	Sydney. Fort Macquarrie.
	2	α −63 04 β −62 40	−62 52	
Dec. 11.	1	α −69 07 β −69 10	−69 09	Three Hummock Island. Bass's Strait
	2	α −69 00 β −69 16	−69 08	
1839.				
Mar. 21.	1	α −62 48 β −62 41	−62 45	Dunheved. Captain King's Observatory.
	2	α −62 57 β −62 34	−62 45	
April 16.	1	α −62 41 β −62 56	−62 48	Sydney. Fort Macquarrie.
	2	α −62 42 β −63 02	−62 52	

* With a circle and needles made by Dollond.

F.

Captain FREDERICK BEECHEY's observations of the dip were made with a six-inch circle and needle by ROBINSON.

Date.	Poles. α direct. β reversed.	Positions of the needle. a.	a′.	a″.	a‴.	Dip.	Station.
1836. Feb. 20.	α	−13° 28′·2	−13° 00′·8	−13° 27′·5	−13° 15′·8	−12° 54′	Rio de Janeiro.
	β	−10 33·3	−13 34·1	−13 18·6	−12 37·1		
Mar. 18.	α	−23 42·7	−21 09·9	−22 54·7	−22 06·2	−21 40	St. Catherine.
	β	−19 34·3	−20 25·3	−22 17·8	−21 06·5		
	α	−23 38·5	−20 57·5	−22 55·5	−22 06·2	−21 39	
	β	−19 51·6	−21 11·2	−22 11·1	−20 25·3		
July 2.	α	−38 27·7	−37 55·6	−38 47·9	−37 19·4	−37 03	Valparaiso.
	β	−36 06·2	−36 06·8	−35 56·1	−35 49		
	α	−38 45·4	−37 16·9	−38 20·9	−38 02·2	−37 07	
	β	−36 10·1	−35 54·8	−36 17·4	−36 06·9		

G.

The observations of Captain CHARLES DRINKWATER BETHUNE, R.N., were made with an instrument by ROBINSON of six inches diameter, furnished with two needles. The usual series of eight readings in different positions of the circle and needle were made, and the results are a mean of those given by the two needles. The readings in the different positions accorded well, as is usually the case in ROBINSON's instruments. Captain BETHUNE's report contains the details of the eight readings in each observation, but without specifying the positions to which they respectively belong. The results at the three stations employed in this paper are a part of an extensive series, chiefly in India and the Pacific Ocean, which will come under notice at a subsequent period, when observations now making in those quarters of the globe shall be completed; the details of Captain BETHUNE's observations at the three stations now employed will be more conveniently given at that time.

H.

The observations of Commander WILLIAM ALLEN, R.N., were made with a circle of JONES with two needles, in both of which the readings, when the poles were changed, differed considerably. The results have been deduced by the known formula

$$\tan I = \frac{\tan M + \tan M'}{2},$$

wherein M is a mean of the readings in the usual four positions with the poles direct, and M′ the same with the poles reversed.

The present amount of the secular change of the dip in the Gulf of Guinea and its vicinity is so considerable, as to render it necessary to apply a correction to Captain ALLEN's results obtained in the year 1833, to make them correspond to the mean epoch of the observations which the map represents, or to the beginning of 1837. From the best inference I am able to draw, in the absence of precise data, the north dip is diminishing, and the south increasing, in the vicinity of the islands of Fernando Po and St. Thomas, at an annual rate certainly exceeding half a degree. At Captain ALLEN's stations in the Quorra the rate of decrease (of north dip) is probably less, but is still very great. The correction applied has been, for three years, at the annual rate of half a degree for the islands in the Gulf of Guinea, and a quarter of a degree for those in the Quorra: the results so corrected are inserted in the map. At Ascension the secular change probably does not exceed 8′ or 10′*: also Captain ALLEN's observations at that island were made a year later than at the other stations; they have not therefore been corrected for epoch. The discrepancy in the results of different observers at Ascension and of the same observer in different situations in the island are well known to be considerable, and are naturally accounted for by its volcanic character. The mean of Captain ALLEN's results agrees well with Captain FITZROY's in 1836.

Date.	Needle.	Poles. α direct. β reversed.	Positions of the needle.				Dip.	Reduction to Epoch.	Dip in 1837.	Station.
			a.	a′.	a″.	a‴.				
1833.			° ′	° ′	° ′	° ′	° ′	° ′	° ′	
Aug. 21.	2	α	7 22	8 29	6 59	8 33	11 53	−0 45	10 58	Stirling.
		β	14 25	16 27	17 20	14 59				
Mar. 22.	1	α	9 43	10 58	10 25	10 14	11 34			
		β	12 29	13 52	12 50	12 00				
Oct. 10.	2	α	10 05	10 17	9 53	10 55	13 51	−0 45	13 06	Egga.
		β	16 55	18 28	17 27	16 22				
Nov. .	1	α	− 0 45	+ 0 20	− 0 39	− 0 10	0 48	−1 30	− 0 42	Fernando Po.
		β	+ 1 55	+ 2 26	+ 1 18	+ 1 57				
Nov. .	2	α	− 0 55	+ 0 28	+ 0 31	− 0 10	0 48			
		β	+ 0 57	+ 2 33	+ 1 51	+ 0 52				
Dec. 27.	1	α	− 8 26	− 8 30	− 7 13	− 8 52	− 7 44	−1 30	− 9 14	Isla de Rolhas.
		β	− 7 15	− 7 04	− 6 46	− 7 52				
1834.										
Jan. 17.†	1	α	1 03	0 30	1 59	1 48	2 31	0 00	1 57	Ascension.
		β	3 06	4 37	3 25	3 41				
Jan. 21.‡	1	α	2 15	2 19	1 12	0 40	2 24			
		β	3 35	3 28	3 57	2 46				
Jan. 24.§	1	α	0 37	0 18	1 1	1 15	0 57			
		β	2 05	2 30	3 10	3 03				

I.

Captain WICKHAM's intensity observations were made with HANSTEEN's apparatus, and two needles Y and Z. The following Table contains their times of horizontal vibration at the stations, dates, and temperatures specified, taken, with Captain BEAU-

* Voyage of H.M. ships Adventure and Beagle, vol. i. p. 527.

† On the sea-beach. ‡ At the spot where Captain FOSTER observed. § On the summit of the Green Mountain.

FORT's permission, from Captain WICKHAM's Report in the Hydrographic Office. The experiments to determine the effect of differences of temperature on the times of vibration do not appear to have been yet made, and are probably deferred until Captain WICKHAM's return to England at the conclusion of the service on which he is still employed. The provisional results which are here computed are therefore necessarily uncorrected for temperature.

Station.	Date.	Needle Y.		Needle Z.		Dip.
		Time.	Therm.	Time.	Therm.	
		s	°	s	°	° ′
Plymouth	June 26, 1837.	806·5	71	883·3	72	69 12
Santa Cruz..........	July 21, 1837.	691·7	87	750·6	88	57 48
Bahia	Aug. 31, 1837.	610·9	86	660·5	88	5 35
Cape of Good Hope ..	Sept. 27, 1837.	725·3	65	781·9	73	−52 53
Swan River	Nov. 22, 1837.	655·1	79	702·4	79	−62 23
Point Swan	Feb. 5, 1838.	578·9	93	632·9	93	−43 07
Port Usborne	March 24, 1838.	584·1	99	627·2	99	−43 26
Port George IV.......	April 15, 1838.	577·6	94	619·6	93	−41 29
Swan River	June 15, 1838.	662·7	64	710·8	63	−62 25
Hobart Town	July 16, 1838.	742·2	54	795·7	54	−70 25
Sydney	Oct. 25, 1838.	661·2	71	709·1	71	−62 53
Three Hummock Island	Dec. 11, 1838.	724·7	70	778·3	69	−69 08
Dunheved	March 22, 1839.	664·1	78	712·4	80	−62 45
Paramatta	April 4, 1839.	660·9	67	708·4	67	−62 50
Sydney	April 16, 1839.	661·8	70	709·9	69	−62 50

The observations of this series furnish tests of the steadiness of the magnetic condition of the needles, or of the changes undergone by them in this respect, during two intervals, viz. from the 22nd of November 1837 to the 15th of June 1838, at both which dates they were vibrated at Swan River; and from the 25th of October 1838 to the 16th of April 1839, at both which dates they were vibrated at Sydney. In the second interval neither needle appears to have sustained any change deserving of notice; the times of vibration in October 1838 and in April 1839 differing only within the limits of the known fluctuations of the horizontal force at the same station on different days, and even on the same day. Between the observations at Swan River in November 1837 and June 1838, both needles appear to have lost force, equivalent in the case of Y to $7^s{\cdot}6$ in $662^s{\cdot}7$, and in that of Z to $8^s{\cdot}4$ in $710^s{\cdot}8$. During the remaining portions of the series, viz. from June 26, 1837, to November 22, 1837, and from June 15, 1838, to October 25, 1838, the observations furnish no direct or independent means of testing the needles; but an attentive consideration of their times of vibration leads to the inference, that Y must have lost magnetism considerably between June and November 1837, and that the loss took place in all probability in the early period of the voyage, or between Plymouth and Santa Cruz; whilst in the case of Z, there is no indication of any other loss than that shown to have taken place by the observations at Swan River. Admitting and allowing for that loss, and supposing no other to have taken place, the values of the intensity given by this needle, at stations where the values are approximately known by the concurrence of other observers of recent date, are as follows, proceeding from Plymouth as a base station:

Cape of Good Hope . . . 1·030; and by other observers . . 1·016*
Hobart Town . . . . . . 1·830; and by other observers . . 1·814†
Sydney . . . . 1·691; and by other observers . . 1·675‡.

Captain Wickham's values, it may be seen, are *in excess*, which is a difference of a contrary nature to that which would have been occasioned by a *loss* of magnetism; we may therefore conclude, with much probability, that needle Z sustained no notable loss of magnetism during the whole of its employment, except that which the observations at Swan River show to have taken place between November 1837 and June 1838: the results with this needle, contained in the next Table, have been computed accordingly.

In the case of needle Y, which appears to have lost magnetism between Plymouth and Santa Cruz, but to what amount the observations supply no certain means of deciding, we may take as base-stations, from the other extremity of the series, Sydney and Hobart Town, where we have already seen that the values of the intensity are approximately known, viz. 1·675 and 1·814. Allowing the loss of 7^{s}·6, evidenced by the observations at Swan River, the results computed with this needle at Santa Cruz, and all the subsequent stations, accord well with those of needle Z, and with those of other observers; whence we may infer with much probability, that between July 1837 at Santa Cruz, and April 1839 at Sydney, needle Y sustained no other loss of magnetism than that deducible from the observations themselves. The results with this needle contained in the next Table have been computed accordingly.

The loss of magnetism between the observations at Swan River in November 1837 and June 1838, has been regarded as a gradual and uniform loss during the whole interval, in the absence of any satisfactory evidence to the contrary.

The results thus computed and inserted in the following Table must be considered as strictly provisional; the *absolute* measurements of the intensity about to be executed at the Cape of Good Hope by Lieut. Eardley Wilmot, R.A., and at Sydney and Van Diemen's Land by Captain James Ross, R.N., will supply important stations of reference in the ultimate revision of this series; based on exact measures at these stations, and corrected for the variations of temperature, Captain Wickham's observations may be expected to give the relative values of the intensity at the intermediate stations, with, what would now at least be considered, a high degree of precision.

* Cape of Good Hope	FitzRoy	1836	1·014	1·011.
	Franklin	1836	1·008	
† Hobart Town	FitzRoy	1836	1·817	1·814.
	Franklin	1837, 1838	1·810	
‡ Sydney	Dunlop	1831	1·665	1·675.
	FitzRoy	1836	1·685	

Santa Cruz	Y = 1·284;	Z = 1·270;	Mean = 1·277
Bahia	= 0·879;	= 0·877;	= 0·878
Cape of Good Hope . . .	= 1·032;	= 1·030;	= 1·031
Swan River	= { 1·647; 1·643;	= 1·665; = 1·661;	= 1·654
Point Swan	= 1·341;	= 1·306;	= 1·324
Port Usborne	= 1·337;	= 1·343;	= 1·340
Port George IV.	= 1·329;	= 1·339;	= 1·334
Hobart Town		= 1·830;	= 1·830
Sydney		= { 1·694; 1·693; }	= 1·693
Three Hummock Island . .	= 1·788;	= 1·799;	= 1·793
Dunheved	= 1·657;	= 1·671;	= 1·664
Paramatta	= 1·681;	= 1·697;	= 1·689

K.

These observations were made with a needle belonging to myself, which Sir John Franklin took out with him to Van Diemen's Land, on his proceeding to assume the government of that island. It was one of those which Mr. David Douglas had employed in magnetic observations in North America and the Sandwich Islands, and had preserved its magnetism unchanged for several years antecedent to Sir John Franklin's departure. The following account of its times of vibration at Hobart Town shows that its magnetism was equally steady after its arrival there, and affords presumptive evidence that it had been so in the interval. This presumption is corroborated by the remarkable agreement of the intensities obtained with it at the Cape of Good Hope and Hobart Town, with those of Captain FitzRoy in 1836 at the same places. The account is copied from a memorandum in my possession received from Sir John Franklin. A second needle which accompanied it proved too unsteady in its magnetism to yield any useful results.

"Rates of Major Sabine's intensity needle six inches long, suspended by a fine thread of unspun silk.

"Dublin, July 20th, 1836: Provost's Garden, Trinity College, dip 70° 59'·5: therm. 59°·3: 10 vibrations in 57·88 seconds. Observer, Major Sabine.

"Cape of Good Hope, November 1836: observatory, dip 52° 38': 10 vibrations in 50·182 seconds: therm. 74°. Observer, Lieut. Thomas Burnett, R.N.

"Hobart Town, January 24th, 1837: in the Garden at Government House; 10 vibrations in 49·88 seconds: therm 64°. Observer, Lieut. Thomas Burnett, R.N.

"Hobart Town, May 4th, 1838: in cottage-garden, ten feet from west window: 10 vibrations in 50·970 seconds: therm. 53°. Observer, Captain Charles Drinkwater Bethune, R.N.

"HOBART TOWN, May 21st, 1838: at the Stone in the Government Garden: 10 vibrations in 50·033 seconds: therm. 63°·5. Observer, Captain CHARLES DRINKWATER BETHUNE, R.N.

"HOBART TOWN, July 18th, 1838: Government House: 10 vibrations in 50·28 seconds: therm. 57°·25: dip, observed at the same spot with two of Mr. Fox's instruments, 70° 31'·5. Observer, Commander JOHN WICKHAM, R.N."

The correction for differences of temperature at the times of vibration of this needle, experimentally determined, is found by the formula

$$T - T' = \cdot 0003\, T' (t - t');$$

in which T' is the observed time of vibration corresponding to the actual temperature t', and T the corrected time corresponding to the standard temperature t. The corrected times of vibration at 60° FAHR. are as follows:

Dublin	57·89 seconds.
Cape of Good Hope	49·97
Hobart Town, January 1837	49·82
Hobart Town, May 4, 1838	51·07
Hobart Town, May 21, 1838	49·98
Hobart Town, July 18, 1838	50·32

Whence the values of the intensity are as follows, Dublin being 1·399*:

Cape of Good Hope	1·008
Hobart Town	1·810

The values determined by Captain FITZROY in 1836† were,

Cape of Good Hope	1·014
Hobart Town	1·817

L.

Mr. Fox's series of intensity results in France, Switzerland, and Germany, were obtained in the summer of 1838, with a four-inch needle deflected by the weights specified in the subjoined Table. The angles are half the sum of the deflections to the right and to the left, and are corrected for temperature at the rate of 2' for one centesimal degree, determined experimentally for the actual angles. In reference to these observations, (and to those of the dip in the Table in page 137.) Mr. Fox remarks, that he always waited till the needle was at rest, and then repeatedly moved it, by turning a little the concentric disk and bracket from behind, reading off again and again when the needle had settled after the application of gentle friction. This he generally did at least three times before he noted the results, so that in fact the

* Magnetic Survey of the British Islands, British Association Report, 1838, p. 191.

† Variations of the Magnetic Intensity, British Association Report, 1837.

observation at each station might be derived, with few exceptions, from the result of thirty or forty readings, or upwards.

Station.	Weights.	Angles of deflection.	Intensity. London = 1·000.		Intensity. = 1·372.	Date.	Locality.
	grs.	° ′				1838.	
London	2·0	48 34	1·000	1·000	1·372	May 22.	Mean result at three stations.
	2·1	51 55	1·000			June 4.	
	2·2	55 33	1·000			June 8.	
Rotterdam ..	2·0	49 16	·9894	·9891	1·357	May 18.	Field west of the city.
	2·1	52 45	·9889				
Arnheim	2·0	49 33	·9852	·9841	1·350	May 18.	Open space outside the gate.
	2·1	53 08	·9839				
	2·2	57 00	·9832				
Cologne	2·0	50 08	·9768	·9780	1·342	May 17.	Open space S. of Cathedral.
	2·1	53 30	·9792				
Manheim....	2·0	50 16	·9749	·9754	1·338	May 15.	Garden of Palace.
	2·1	53 50	·9750				
	2·2	57 38	·9763				
Basle	2·0	50 43	·9686	·9685	1·329	May 11.	Place of St. Pierre.
	2·1	54 23	·9683				
	2·2	58 21	·9687				
Berne	2·0	51 28	·9584	·9602	1·318	May 9.	Platform near the Cathedral.
	2·1	55 00	·9608				
	2·2	59 03	·9615				
Geneva	2·0	51 33	·9573	·9594	1·316	May 1.	Outside the city wall at the back of the Hôtel des Bergues.
	2·1	55 04	·9601				
	2·2	59 07	·9608				
Annecy	2·0	51 49	·9538	·9545	1·310	April 30.	Near the lake.
	2·1	55 35	·9542				
	2·2	59 39	·9556				
Nismes	2·0	52 48	·9474	·9467	1·299	April 23.	A garden S.E. of the city.
	2·1	56 52	·9460				
Puy de Dôme	2·0	52 22	·9526	·9517	1·306	April 11.	East side; on lava.
	2·1	56 23	·9512				
	2·2	60 43	·9514				
Nevers	2·0	51 16	·9673	·9672	1·327	April 9.	Open space in front of the barracks.
	2·1	55 03	·9663				
	2·2	59 00	·9680				
Fontainbleau	2·1	54 20	·9749	·9761	1·339	April 6.	English garden at the Palace.
	2·2	58 06	·9773				
Paris	2·0	50 28	·9781	·9794	1·343	March 29.	Garden of the Ecole des Mines.
	2·1	54 01	·9787				
	2·2	57 43	·9813				

Note supplied by Mr. Fox.

"At the first nine stations in this Table, a few fibres only of unspun silk were employed for suspending the weights; but at the last five, a very fine silk thread was used for this purpose, which caused greater leverage on the grooved wheel, and consequently greater deflection of the needle, on which account it was found, after a series of comparative experiments, that ·0060 should be added to the decimals expressing the intensity, which has accordingly been done in the results entered in the Table."

Postscript.—*April* 8, 1840.

Since the above communication was read to the Society, I have received letters from Captain James Clark Ross, commanding the Antarctic Expedition, dated from St. Helena, February 9, 1840, stating that he finds the observations of the magnetic dip and intensity made at sea with Mr. Fox's instrument succeed far beyond his most sanguine expectation. I venture to lay before the Society the following extract from one of his letters, because it is likely to convey, more strongly than any comments of my own could do, a conviction of the value of a class of observations, which it was one of the principal objects of this paper to recommend to more general practice.

"Our Fox's needles are doing their work admirably in both ships: you would be somewhat surprised to see the interchange of signals between the two ships when the dip comes to the *same minute*, and it is seldom more than a few minutes apart when corrected for the deviation due to each vessel; and even this small difference partly occurs from our only at present knowing but imperfectly the values of the corrections. We have however ample means for their determination, and we shall eventually be able to make all the necessary corrections. I feel satisfied that on board ship much of the disturbing influence can be done away with, and the exact value of the remainder can be determined; can we say the same of observations on shore, even under the most favourable circumstances?"